Referee 1 (RC1)

☑**[RC1]** Line 104: Perhaps add a reference to the validation of ERA5 or say something about the confidence of using the dataset. It makes sense to use this dataset for the purpose presented here, but are there modeling issues especially with hourly precipitation that could affect the study results? In other words, what is the confidence in using this dataset and perhaps why was it chosen versus other potential datasets. In the discussion section you do make a reference to extreme-value biases in ERA5.

> ☑**[Authors]** Many thanks for your suggestion and this important point. As noted in Sjöström et al. (2025), the ERA5 reanalysis FWI-values are in general lower than corresponding observational or point observations values over boreal forests in northern Europe. That's why, following these results, we have conducted a comparison between ERA5 FWI-values against observed stations across Canada. As also noted in the recent work of Alpizar et al. (2026) who used precipitation data from ERA5 reanalysis over eastern North America, this product is a global reanalysis with relatively coarse horizontal resolution (i.e. around 31 km) that cannot reproduce extreme-values, such as precipitation from convective events that occur in summer months (see also the study across the Indo-Pacific area from Chan et al., 2022). However, the occurrence of precipitation events is in general well reproduced, even though high intensity rainfalls are strongly underestimated in ERA5 reanalysis products (see Alpizar et al., 2026). Nevertheless, the summertime hourly precipitation is lower while the diurnal cycle is shifted versus local time, when compared with observed radar products (see Alpizar et al., 2026). Such biases could lead to underestimations of high FWI values as noted in our results section (see lines 406-410). These limitations are now included in the conclusion section of the revised version of the manuscript, as it follows: "As noted previously, ERA5 reanalysis is a large-scale reference dataset commonly used in many climate studies, but as suggested in various studies, a careful analysis for extreme-value bias against point observations is needed to prevent any misinterpretation as compared to observational products (see also the recent studies of Alpizar et al., 2026; Chan et al., 2022)."

☑**[RC1]** Line 239: Do you think that there were any issues for this direct grid point comparison in complex terrain?

> ☑**[Authors]** This is a good point. FWI calculations use weather variables such as precipitation and wind speed, which are more likely to vary in space than temperature, for example. These variables are known to be more stochastic by nature and more biased than near surface air temperature obtained from reanalysis products. This effect is further amplified in complex terrain and when we compare point scale observations with coarse scale gridded reanalysis products for misrepresenting precipitation and wind dependencies in high elevation areas (see the recent study of de Padua and Ahn, 2024). The CERRA product user guide reminds us of these limitations when working with reanalyses (see ECMWF, 2025). Following an analysis made for the purpose of this guide, they show that the average value of the four closest grid points should be used instead of the value of a single grid point when comparing reanalysis and observation outputs, since it leads to lower bias. In our case, the direct grid point comparison was first implemented for its simplicity, but we aim to implement the four grid points comparison for the upcoming fire season. Interestingly, while evaluating the best method for determining fire season onset using the ERA5 reanalysis product, we found that the main limitation in complex terrain was related to the representation of snow dynamics. In particular, the product often showed delayed snow ablation, and in some cases simulated snow cover persisted throughout much of the fire season. For example, when examining the 2024 Jasper wildfire in the Rocky Mountains, we found that prior to adjusting the onset calculation method, ERA5 produced unrealistic fire weather outputs over the affected area. In several cases, the dataset yielded no calculated FWI values, or values far lower than those observed in situ. This discrepancy was largely associated with the persistence of modeled snow cover in the reanalysis product, which delayed or prevented the initiation of FWI

calculations. Working on the same case, with the updated methodology this time, we also saw that ERA5 could not produce FWI values as high as those observed in this mountainous area. Rather, the highest value grid points calculated using ERA5 would most of the time be surrounded by grid points with way lower values. Depending on the nature of the comparison (bias, correlation, etc.), using the average value of the four closest grid points could smooth the value even more and lead to higher bias in complex terrain. More work on that issue needs to be done.

☑ **[RC1]** Line 258: 02:00AM is a local time for which time zone?

☑ **[Authors]** 02:00AM is a local time for the Eastern time zone. We added this information in the revised version of the manuscript this way:

"The automation process has an execution time of approximately 1 hour, depending on the speed of access (download time) to ERA5 reanalysis data, and ensure that the following steps are carried out every day of the year at 02:00 AM local time in Eastern time zone (i.e., 07:00 UTC), namely".

☑ **[RC1]** Line 375: Do you have a sense of how different these records would look without the SN methodology?

☑ **[Authors]** This is an interesting question that led us to take out further analysis. The figure below (Figure 6.1) shows the FWI breaking records for the same date shown in Figure 6 (2025/05/29) but, this time, the FWI values were calculated following the UTC method. Results are similar between both methods. Yet, with the UTC method, we see that areas located on the border of British Columbia (BC) and Saskatchewan (SK) show more grid points breaking records for that date as well as more days since the beginning of the fire season breaking daily records (see left panel). When comparing FWI values for that date with historical records for the entire season (right panel), differences between the two methods are less pronounced. Nevertheless, results obtained using the UTC method still show a greater number of grid cells exceeding historical records compared with the SN method, particularly in the region north of the British Columbia–Saskatchewan border. Further explanation concerning these differences are given in the following when considering FWI meteorological/Julian daily values (i.e. May 29th, 2025/May 29th), and climatological ones (for the fire season), as shown in Figures 6.2/6.3 and 6.4, respectively.

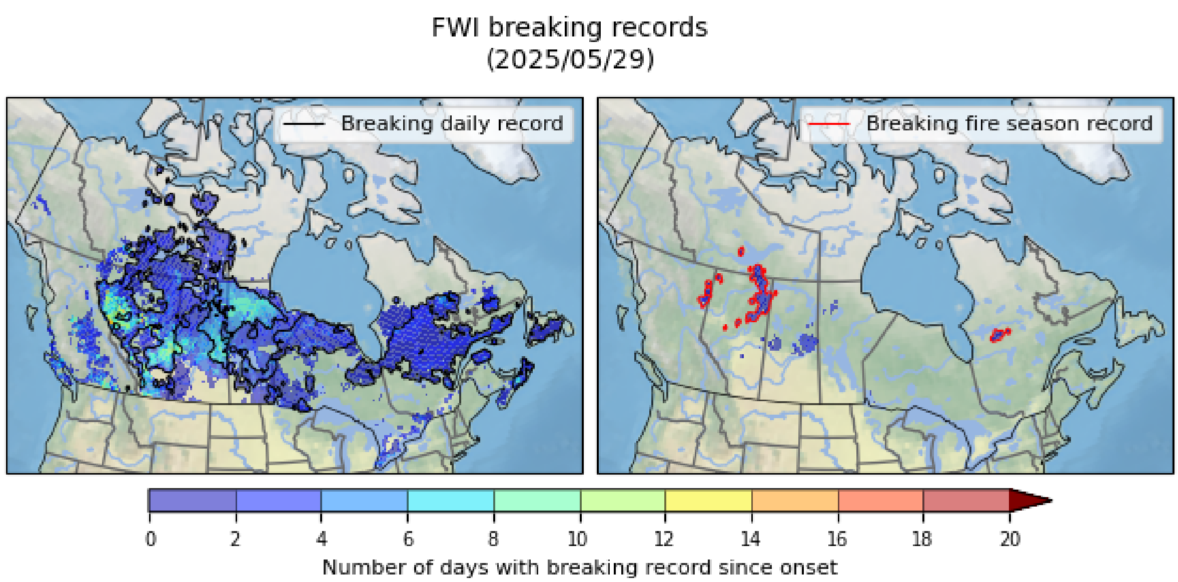

Figure 6.1: FWI breaking records for May 29th of 2025 across Canada, following the UTC method. The left panel map shows areas with FWI values breaking the daily record (for May 29th, in black contours) while the right panel map shows areas with FWI values breaking fire season record (considering the entire fire season, in red contours) for the current day. Colormap represents, locally (spatial resolution of approximately 31 km), the number of days where the daily FWI has been breaking records since the onset. Historical records were calculated over the period 1950-2024.

In the following figures, we present the differences between the two methods (SN − UTC) in daily FWI values for 29 May 2025 (Figure 6.2), as well as the differences in historical record FWI values for the corresponding Julian day (Figure 6.3), as well as in the historical records of FWI daily value over the whole fire season (Figure 6.4). Figures clearly show that strong differences are in the vicinity and along the limits of the UTC time zones (in black contours), and with the higher ones located on the eastern side of the time zone delineations. It is particularly true for historical records over the whole fire season (Figure 6.4) where FWI values calculated using the SN method are way (more often) higher than those calculated using the UTC method.

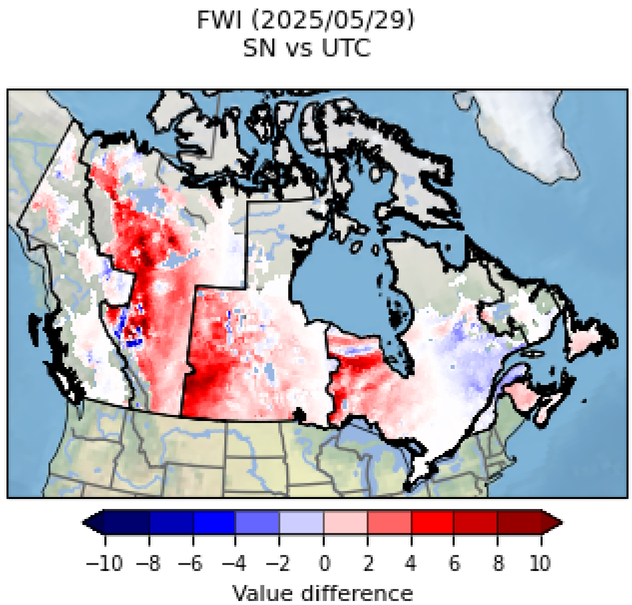

Figure 6.2: Difference in the FWI daily value on May 29th of 2025 between SN and UTC methods.

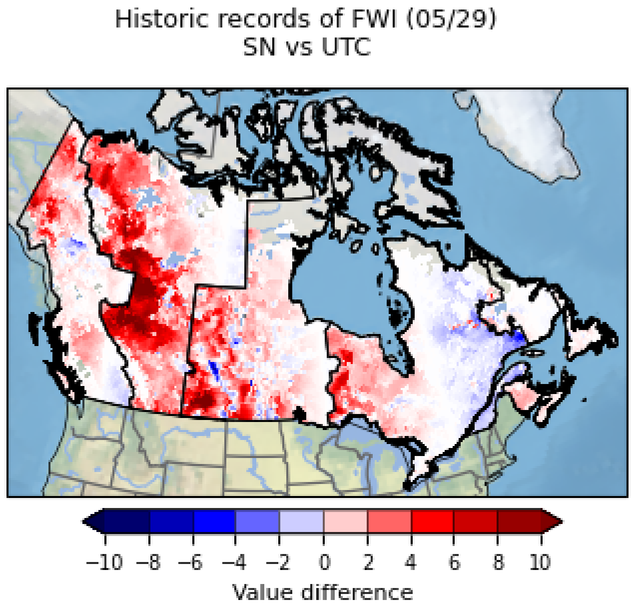

Figure 6.3: Difference in the historical records of FWI daily value on May 29th between SN method and UTC method.

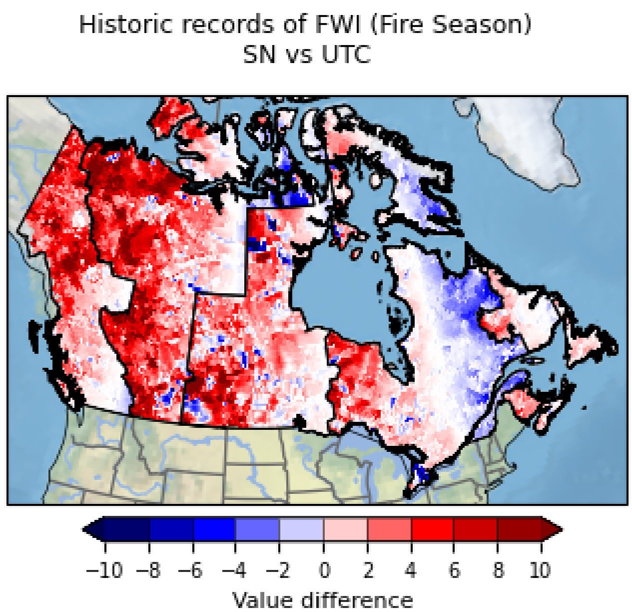

Figure 6.4: Difference in the historical records of FWI daily value over the fire season between SN method and UTC method.

☑**[RC1]** Can you say something a bit more specific regarding management implications of the SN improvement?

> ☑**[Authors]** Sure, many thanks for this suggestion. We are now including the following text in the conclusion section of the revised version of the manuscript: “By providing daily values of the FWI components for each grid point of approximately 31 km across Canada, the FWI-SN dataset contributes to more realistic depiction of the fire danger in regions located far from observational

station data, especially near the time zone boundaries. These data should therefore be of particular interest to fire management agencies as part of their operational systems, especially given that the SN method corrects the strong discontinuities and over- or underestimations in FWI values that occur with the UTC method in regions located near the boundaries between eastern and western time zones. Given the biases introduced by the UTC method, the SN approach would also improve how provinces define fire danger categories based on percentiles, by relying on more realistic grid-based estimates of FWI".

Referee 2 (RC2)

☑**[RC2]** L67: The authors' claim about creating a fine-scale dataset is a bold one, particularly when considering the spatial resolution of the final dataset (~31 km). I suggest removing the "fine-scale" characterization; the authors could perhaps replace it with the term "novel".

> ☑**[Authors]** We propose to use "high-resolution gridded dataset" instead of "fine-scale gridded dataset". However, we believe that both terms can apply to the ERA5 horizontal resolution (~31 km). In literature, the term "fine grid" is used to define gridded data with spatial resolution in a range from 10 to 50 km, but the ECMWF also use "high resolution realisation" to talk about the ERA5 dataset (see https://confluence.ecmwf.int/display/CKB/ERA5%3A+data+documentation).

☑**[RC2]** Considering the arguments made by the authors in articulating their motivation, as well as the comparison and validation results presented, I believe it would be very interesting to expand the analysis and discussion beyond the absolute FWI values. While those are certainly useful and the results indicate the added value of the approach proposed, the greatest interest lies in evaluating the impact of the SN approach on threshold- and percentile-based FWI values. For instance, I could argue that an enhancement of the accuracy in computed FWI by 2 units does not have much meaning if the resulting FWI corresponds to the same level of fire danger. On the other hand, if the refined FWI computation methodology yields a different "picture" when it comes to danger days or extreme days, then the added value for operational fire management would be larger and should be highlighted.

> ☑**[Authors]** Many thanks for this relevant comment. The main idea of this project was to develop a gridded dataset of the daily FWI indices across Canada, using ERA5. The SN method was brought afterwhile when we realised that the results obtained with the UTC method were not making sense with the "physical" reality, with important discontinuities in values across the time zones limits, a "non-physical" object. The SN method was developed and tested to make sure that it was correcting these discontinuities while still being in line with the results obtained with the UTC method. Yet we are aware that the evaluation we made of the SN method compared to the UTC method is certainly limited and your comment brings important considerations we dismissed that should be studied in further works. We have already considered calculating risk indices based on threshold- and percentile-based values of the FWI components in future work, as the absolute value of the FWI (or any other FWI component) does not always accurately reflect the actual fire risk in a given region. In an operational context, identical values observed in different regions may therefore have very different interpretations.
>
> We therefore suggest adding the following information in the conclusion section of the revised manuscript: "The analysis conducted so far comparing the SN and UTC methods remains limited, as it does not address how the two methods perform with extreme values or how these extremes relate to historical observations. In future work, we aim to develop risk indices based on threshold- and percentile-based FWI component values. These indices will be calculated using

both the SN and UTC methods to extend the analysis and better demonstrate the added value of the SN method, particularly in an operational context."

You may also find our response to Referee 1's comment on Figure 1 of interest. In this context, we produced the same figure using the UTC method, as well as additional figures that allow a comparison of both methods for FWI record-breaking events. This analysis should be extended in further works, but the current results suggest that the UTC method likely underestimate the 'high' danger classes, with this underestimation increasing toward the western boundary of the time zone. As suggested by other reviewers, we have also added a sentence in the conclusion of the revised manuscript for the benefit of operational management (see answer given at RC1's comment "Can you say something a bit more specific regarding management implications of the SN improvement?").

Finally, as noted in the discussion section, we currently use the SN method to identify and evaluate the changes in the FWI System components and in forest fire danger from simulations of our high-resolution regional climate model under climate change at 12 and 2.5 km of resolution. The benefit of using the SN method is more obvious with higher resolution products, to prevent strong discontinuities near time zone boundaries including during days under high percentile-based FWI values.

References

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